# इंटरनेट मानक

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Whereas the Parliament of India has set out to provide a practical regime of right to information for citizens to secure access to information under the control of public authorities, in order to promote transparency and accountability in the working of every public authority, and whereas the attached publication of the Bureau of Indian Standards is of particular interest to the public, particularly disadvantaged communities and those engaged in the pursuit of education and knowledge, the attached public safety standard is made available to promote the timely dissemination of this information in an accurate manner to the public.

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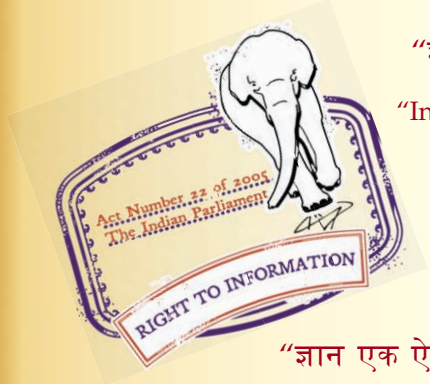
IS 6269 (1971): Code of safety for ethylene oxide [CHD 8: Occupational Safety, Health and Chemical Hazards]

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"Invent a New India Using Knowledge"


"ज्ञान एक ऐसा खजाना है जो कभी चुराया नहीं जा सकता है"
Bhartṛhari—Nītiśatakam
"Knowledge is such a treasure which cannot be stolen"

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**IS : 6269 - 1971**
(Reaffirmed 2009)
**Edition 1.1**
**(2006-12)**

# *Indian Standard*

# CODE OF SAFETY FOR ETHYLENE OXIDE

(Incorporating Amendment No. 1)

UDC 614.878 : 547.422.2



**BUREAU OF INDIAN STANDARDS**
MANAK BHAVAN, 9 BAHADUR SHAH ZAFAR MARG
NEW DELHI 110002

**Price Group 5**

# AMENDMENT NO. 1 DECEMBER 2006
# TO
# IS 6269 : 1971 CODE OF SAFETY FOR ETHYLENE OXIDE

(*Page* 5, *clause* **4.1**, *line* 3) — Substitute '1 ppm' *for* '50 ppm' and insert the following at the end:

'Ethylene oxide is suspected human carcinogen'.

(*Page* 6, *clause* **4.1.3)** — Insert the following at the end:

'Ethylene oxide may cause cancer and heritable genetic damage.'

(*Page* 6, *clause* **4.4.2)** — Insert the following new clause after **4.4.2:**

**'4.5 Incompatibles** — Ethylene oxide is very reactive with metal oxides, metals such as sodium, potassium and barium, acids, alcohols, alkalis, ammonia, ferric salts and water.'



Reprography Unit, BIS, New Delhi, India

# *Indian Standard*

# CODE OF SAFETY FOR ETHYLENE OXIDE

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( *Continued on page* 2 )

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# *Indian Standard*

# CODE OF SAFETY FOR ETHYLENE OXIDE

## 0. FOREWORD

**0.1** This Indian Standard was adopted by the Indian Standards Institution on 17 August 1971, after the draft finalized by the Chemical Hazards Sectional Committee had been approved by the Chemical Division Council.

**0.2** A complete knowledge and understanding of the hazards of ethylene oxide is essential for its safe handling in industry. This standard attempts to guide the users in the recognition of these hazards and in the recommended handling procedures. The information given should be utilized to the fullest extent and should be supplemented with additional information on design aspects of plants and equipment.

**0.3** In the preparation of this standard, considerable assistance has been derived from Safety Data Sheet SD-38 'Ethylene Oxide' issued by Manufacturing Chemists Association, Washington, USA.

**0.4** This edition 1.1 incorporates Amendment No. 1 (December 2006). Side bar indicates modification of the text as the result of incorporation of the amendment.

## 1. SCOPE

**1.1** This standard describes properties of ethylene oxide, the nature of hazards associated with it and essential information on storage, handling, packing, labelling, disposal of waste, cleaning and repair of tanks and equipment, selection and training, personal protective equipment and first-aid.

**1.1.1** This code does not deal with specifications for design of buildings, chemical engineering plants, storage vessels, equipment for waste disposal and operations control.

## 2. TERMINOLOGY

**2.1** For the purpose of this standard, the definitions given in IS : 4155-1966* and IS : 4167-1966† shall apply.

*Glossary of terms relating to chemical and radiation hazards and hazardous chemicals.

†Glossary of terms relating to air pollution.

## 3. PROPERTIES OF ETHYLENE OXIDE

**3.1** Some important properties are:

| *Property* | *Liquid* | *Gas* |
|---|---|---|
| Boiling point (760 mm) | 10.73 °C | — |
| Coefficient of expansion: | | |
| 20°C | 0.001 61 per °C | — |
| 55°C | 0.001 70 per °C | — |
| 73.9°C | 0.002 05 per °C | — |
| Colour | Colourless | Colourless |
| Explosive limits, percent by volume in air: | Non-explosive | Explosive |
| Upper limit | — | 100 |
| Lower limit | — | 3 |
| Flash point, (Open cup) | – 18°C | — |
| Heat of combustion, kcal/g mol | — | 308.7 |
| Heat of decomposition, kcal/g mol | — | 20.0 |
| Hygroscopicity | Slight | — |
| Ignition temperature; in air, 1 atm | — | 429°C (The presence of magnesia lagging depresses this temperature to 270°C) |
| Ignition temperature: (auto ignition) 1 atm | — | 571°C |
| Melting point | – 111.3°C | — |
| Odour | Characteristic ether-like odour, but irritating in high concentration | Characteristic ether-like odour, but irritating in high concentration |
| Reactivity, chemical | Dangerously reactive; some reactions uncontrolled | Dangerously reactive; some reactions uncontrolled |

| *Property* | *Liquid* | *Gas* |
|---|---|---|
| Relative density, 20°/20°C | 0.871 1 | — |
| Solubility in water | Complete | — |
| Vapour density (air = 1), at 40°C | — | 1.49 |
| Volatility | Very volatile | — |
| Vapour pressure | — | ( *see* below ) |

**Vapour Pressure of Ethylene Oxide**

| *Temperature* °C | *Vapour Pressure* mm Hg abs |
|---|---|
| – 57.0 | 19.5 |
| – 30.4 | 110.6 |
| – 10.5 | 312.7 |
| 0.0 | 493.1 |
| 10.73 | 760.0 |
| 20.0 | 1 095.0 |
| 30.0 | 1 560.0 |
| 69.8 | 5 141.0 |
| 109.8 | 12 720.0 |

## 4. HAZARDS ASSOCIATED WITH ETHYLENE OXIDE

**4.1 Health Hazards** — Ethylene oxide vaporizes rapidly at atmospheric temperatures and pressures. Its vapour is moderately toxic by inhalation. The threshold limit value (TLV)* of ethylene oxide in air is 1 ppm (90 mg/$m^3$) for 7 to 8 hours work-day and 40 hours work-week. Ethylene oxide is suspected human carcinogen.

**4.1.1** Low ethylene oxide concentration may be detected easily by smell. However, continued exposure to ethylene oxide will numb the sense of smell, and consequently higher concentrations may be reached before the distinctive odour becomes apparent. This may lead to severe nausea and vomitting.

**4.1.2** *Acute Toxicity*

**4.1.2.1** *Systemic effects* — When excessive amounts of ethylene oxide are inhaled, they have a general anaesthetic effect as well as causing coughing due to irritation of the respiratory system. The victim may become nauseated and vomit.

*As accepted by American Conference of Governmental Industrial Hygienists, Ohio, USA.

**4.1.2.2** *Local effects* — The vapour will cause eye and nasal irritation when present in excessive amounts. The liquid or solutions on the exposed skin do not cause skin irritation immediately, but when spilled in the shoes or on the clothing, delayed skin burns may occur if the clothing and shoes are not promptly removed. The liquid or solutions may cause severe eye burns. Vapour has been known to produce skin irritation and burns from its absorption in areas of heat and moisture about the body.

**4.1.3** *Chronic Toxicity* — No cases of chronic poisoning due to ethylene oxide have been reported. Ethylene oxide may cause cancer and heritable genetic damage.

**4.2 Fire Hazards** — Ethylene oxide is an extremely flammable liquid and, as such, introduces a potential fire hazard when it is stored, handled or used. Ethylene oxide fires will continue to burn until the liquid is diluted with approximately 22 volumes of water to one volume of oxide. Water is to be used for most fires. Most small fires may be extinguished with carbon dioxide or dry chemical agents, if properly applied. For large fires, water applied as a fire spray and carbon dioxide should be used. A dependable fire alarm system and adequate fire fighting equipment should be provided in the handling areas.

**4.3 Explosion Hazards** — Liquid ethylene oxide itself is quite stable to detonating agents, but the vapour will explode when exposed to an electric spark, static electricity, excess heat, an open flame, decomposing acetylides, or detonating agents. Vapour and air mixtures are more explosive than the vapour alone and shall be handled accordingly. In a confined space, the explosion pressure developed may be in the range of 16 to 50 (plus) times the initial pressure depending on the initial pressure and the volume-to-surface ratio of the container. As the volume-to-surface ratio of the container is increased, pressure might be developed in excess of 50 times the initial pressure. Explosions from internal sources may be prevented by proper dilution with an inert gas such as nitrogen. Even in the presence of a blanket gas, ethylene oxide vapours can explode in the absence of air or oxygen at 571°C. Ignition from outside sources should be guarded against by adequate insulation and water spray systems.

**4.4 Polymerization Hazards**

**4.4.1** Ethylene oxide may rearrange chemically and/or polymerize violently when in contact with highly active catalytic surfaces such as anhydrous iron, tin and aluminium chlorides; pure iron and aluminium oxides; and alkali metal hydroxides.

**4.4.2** Ethylene oxide may also react with other materials and thus create enough heat to accelerate polymerization of unreacted oxide.

**4.5 Incompatibles** — Ethylene oxide is very reactive with metal oxides, metals such as sodium, potassium and barium, acids, alcohols, alkalis, ammonia, ferric salts and water.

## 5. STORAGE

**5.1 Volatility** — Ethylene oxide is very volatile and should be stored under pressure with adequate cooling.

**5.2 Temperature Requirements** — Ethylene oxide in storage tanks should be maintained at a temperature not exceeding 30°C.

**5.2.1** Wherever possible refrigerated storage, held preferably at temperatures below the boiling point of ethylene oxide (10.7°C), is recommended, since not only does this further reduce the risk of uncontrollable polymerization developing in the liquid phase but it also reduces the rate of build-up of polymer which not only adversely affects the quality of products made from the ethylene oxide but also chokes valves and lines. However, the temperature should not be much lower since hydrates may form and block emergency drain or dump valves. Refrigerated storage should obviously be lagged.

### 5.3 Pipe Work, Valves and Pumps

**5.3.1** Pipework should consist of all-steel welded construction with flanged or welded joints. However, wherever possible flanged joints should be minimized and there should be provision for nitrogen purging of ethylene oxide containing lines. Whenever there is any risk of exposure to heat, pipe lines should be lagged. Because lines should never be left containing static ethylene oxide liquid, which might polymerize and choke the line, pipe runs should be self draining or, if this is impossible, any low portions should be fitted with drain valves Spirally wound stainless steel gaskets with polytetrafluoroethylene lining are recommended for flanged joints which should be fitted with earthing strips to provide an earthing system for static electric charges.

**5.3.2** Valves should be of all steel construction, ball valves being used for shut-off operation and globe valves for control purposes.

**5.3.3** Iron and steel centrifugal pumps are satisfactory, but it is recommended that they should be either of the glandless type or fitted with a rotating seal. Provision should be made such that the pumps do not run dry or overheat.

**5.3.4** Copper or other acetylide-forming metals, such as silver, magnesium and their alloys should not be used as materials of construction for equipment handling ethylene oxide. Mercury-filled instruments should be provided with mercury traps and an inert gas purge which is free of acetylene and carbon dioxide. All-welded construction is preferred to riveted construction. Storage tanks should

be equipped with stainless steel cooling coils and should be well insulated, preferably with mineral wool covered with galvanized iron sheets in order to minimize fire hazards. All liquid inlet lines should enter or lie extended to the bottom of the vessel to prevent the generation of static electricity. All equipment should be properly grounded and an efficient water spray system should be installed. Adequate diking and drainage should be provided in the tank area to confine and dispose of the liquid in case of tank rupture.

**5.4 Isolation** — Local building codes should be followed strictly. Ethylene oxide storage tanks should be isolated from continuous ignition sources such as boiler houses. If possible, storage tanks should be located outside the buildings. It is preferable to store the cylinders in the open, but provision should be made to shield them from the direct rays of the sun and to prevent accumulation of dirt, water, or ice on valves or safety devices. The use of an open-sided storage shed is suggested.

**5.5 Compatibility with Other Materials** — Storage tanks in ethylene oxide service should be used only for ethylene oxide unless thoroughly cleaned and purged. Ethylene oxide reacts exothermically with such compounds as alcohols, amines, ammonia, and organic and mineral acids. Before a tank is placed in ethylene oxide service, it should be cleaned thoroughly, flushed with water and dried. Before ethylene oxide is placed in the tank, the vessel should be purged with an inert gas until free of air. The oxygen content of the vessel should not be greater than 0.2 percent by volume.

**5.6 Electrical Equipment** — All electrical equipment, motors, lights and flash lights used in an area in which ethylene oxide is stored or handled should conform to the Indian Standard specification, if any, and should be vapour-tight.

**5.7 Explosion Venting Requirements** — An adequate system for normal and emergency venting should be installed. All vent lines should extend to a safe area. The point of outlet should be equipped with an approved flame arrestor. Relief valves should be installed in pairs to facilitate periodic testing and repairing, The vent line should be equipped with a connection for emergency purging with steam, nitrogen or carbon dioxide for the extinguishment of any fire occurring on the outlet side of the flash arrestor.

**5.8 Ventilation** — All storage areas should be provided with continuous ventilation. Pits, depressions and basements should be avoided.

**5.9 Grounding** — Storage tanks for ethylene oxide should be protected from electrical storms and induced static electricity by the grounding of all equipment.

**5.10 Ignition Protection** — Storage tanks and other equipment should be maintained under an inert atmosphere in a non-flammable range during all transfers, as well as during stationary conditions, to prevent possible ignition in the vapour phase within the vessel. Vessels should be provided with bottom inlets under the liquid, or tangented nozzles to prevent static sparks.

## 6. HANDLING

### 6.1 Spills and Leaks

**6.1.1** Frequent inspections of equipment and vessels containing ethylene oxide should be made to detect or prevent leaks.

**6.1.2** If leaks or spills occur, only properly protected personnel should remain in the area.

**6.1.3** All spills should be flushed away promptly with a large quantity of water. All openings in sewer system should be trapped for segregation and extinguishment. All sources of ignition should be removed.

**6.1.4** If possible, increased ventilation should be provided. Inhalation of vapours should be avoided.

**6.1.5** All articles of clothing, including shoes, wet with ethylene oxide or exposed to oxide vapours should be removed immediately and the body washed to remove any of the ethylene oxide which has penetrated the clothing. Clothing should be washed before re-use.

**6.1.6** A leaking container should be removed to an isolated, well-ventilated area and the contents transferred to other suitable containers. Unloading rules set forth in **6.3** should be observed.

**6.1.7** In the event of tank car leakage, dilute the leakage with a large quantity of water, and make necessary repairs, if possible. The supplier should be telephoned or wired immediately for specific instructions.

### 6.2 Use in Chemical Reactions

**6.2.1** If it is assumed that the use will consist of feeding a predetermined amount of liquid or gaseous ethylene oxide into a reaction vessel for a batch process, then the recommendations given apply in this respect. If the process differs from this, however, these recommendations may be adapted provided the reasons for the various precautions are kept in mind.

**6.2.2** Because ethylene oxide forms a great many explosive mixtures with other materials and also because its reactions are generally exothermic, special precautions are necessary when adding liquid ethylene oxide to a reaction mixture. A carefully controlled feed rate and a ready means of controlling and observing the reaction temperature are absolutely essential. The addition of ethylene oxide should be made

below the liquid level in the reactor to avoid the possibility of a discharge of static electricity, and provision should be made for some vigorous form of agitation of the reactor contents in order to avoid localized heating. The reactor and all ancillary pipework which may be used in the conveyance of ethylene oxide should be purged with inert gas before each operation, and a blanket of inert gas should be maintained over the contents of the reactor throughout the process.

**6.2.3** The reactor should be fitted with adequate equipment for cooling the charge either by jacketing or by means of cooling coils. Close control of the temperature and pressure in the reactor is important, and it may be desirable to install automatic controllers for both variables.

**6.2.4** If, shortly after the addition of the ethylene oxide has commenced, either a persistent increase in pressure or no increase in temperature has been observed, the addition should be stopped, as otherwise a dangerous amount of unreacted oxide might accumulate. Similarly, if at any time during the addition there is a drop in the temperature or a rise in pressure in the reactor, the addition of ethylene oxide should be stopped. At the end of the addition of the ethylene oxide a drop in these parameters indicates that the reaction is completed.

An adequate system of emergency venting to a safe location should be provided, with facilities for diluting the vented material with water to a safe concentration. The reactor should also be fitted with a safety valve or bursting disc of sufficient size to relieve pressure in the event of an abnormally violent reaction taking place. It should be noted, however, that safety valves and bursting discs are not a safeguard against the effects of an explosion.

**6.2.6** As rust may, in certain circumstances, cause polymerization of ethylene oxide, reaction vessels and other equipment made of mild steel should be freed from rust before being put into service. The use of stainless steel or glass-lined equipment is an additional safeguard.

**6.2.7** Positive steps should be taken to ensure that there is no possibility of the reaction mixture finding its way back to an ethylene oxide storage tank or cylinder. This necessitates the use of non-return valves in the ethylene oxide feed line and preferably also the physical disconnection of the feed line while the reaction is proceeding.

### 6.3 Unloading and Emptying of Containers

**6.3.1** *Tank Cars*

**6.3.1.1** Supplier's instructions should always be followed and all caution markings on both sides of tank and dome should be read and observed.

**6.3.1.2** In the event of a tank car or fitting failure or leak, the supplier should be contacted immediately for instructions.

**6.3.1.3** Tank cars should be electrically grounded to dissipate static or induced lightning charges.

**6.3.1.4** No heat should be applied to the tank car. An inert gas line should be attached to vent connection of the tank car to provide a pressure of 2.5 kg/cm$^2$ and not over 4.6 kg/cm$^2$ for transfer of ethylene oxide from tank car to receiving tank. Nitrogen from a cylinder is often used as the pressurizing medium in the event a suitable inert gas is not available within the plant.

**6.3.1.5** If the tank cars are provided with excess flow check valves, a too rapid opening of the discharge valves will cause the check valves to close. If this should occur, the outlet valve should be closed until the pressure is equalized and the excess flow valve opens.

**6.3.1.6** No air should be allowed to enter the car. The inert gas at 2.5 kg/cm$^2$ pressure should be left in the car for the return of the
empty tank car.

**6.3.2** *Insulated Drums*

**6.3.2.1** Drums should be unloaded carefully to prevent damage. Drums containing ethylene oxide should be set upright during storage and for unloading.

**6.3.2.2** If any leaking drums are found, they should be removed to a safe location where it is possible to stop the leaking or to transfer the contents. It should always be remembered that ethylene oxide vapours are flammable and toxic.

**6.3.2.3** If it is not practical to locate the insulated drum outdoors during unloading, a vent stack or hood equipped with an exhauster should be installed over the drum.

**6.3.2.4** An inert gas is used to empty a drum of its contents. Heating increases the explosion hazards. In addition, heating may cause polymer formation.

**6.3.2.5** If ethylene oxide vapour is required by the user, it will be necessary to provide a vaporizer. The size and arrangement of such vaporizer will be dependent upon the requirements of the user. The vaporizer, however, should be designed to contain a minimum volume of ethylene oxide and to have a maximum surface. If possible, the vaporizer should be located outside of buildings to prevent the accumulation of ethylene oxide vapours in case of any leakage.

**6.3.2.6** When the drum has been emptied of its contents, an inert gas pressure of 2.5 kg/cm$^2$ at 20ºC should be left in the drum for return to the supplier. No air should be allowed to enter the drum.

**6.3.2.7** If the drum is emptied only partially of its contents at any one

usage, total gas pressure of 2.5 kg/cm$^2$ at 20ºC should be left in the drum for storage.

**6.3.3** *Cylinders*

**6.3.3.1** Precautions generally applied to use of small cylinders of flammable liquids should be used.

**6.3.3.2** A water-bath heated to a maximum of 50ºC may be used to empty a small uninsulated cylinder by means of the vapour pressure of the ethylene oxide.

**6.3.3.3** Check valves shall be installed in feed lines from the cylinder to prevent the reactants from entering the cylinder.

**6.3.3.4** When the cylinder is empty, the valves should be closed. Air should not be allowed to enter the container.

**6.4 Filling of Tank Trucks and Cylinders** — The tank trucks and cylinders are thoroughly cleaned inside, dried and purged with nitrogen till the oxygen content is less than 0.2 percent before filling them with ethylene oxide. The filled containers are then pressurized with nitrogen to render the vapour phase mixture non-explosive. Nitrogen is again used for liquid withdrawal by pressure and the empty containers are filled with nitrogen to a pressure of about 2 kg/cm$^2$.

**6.4.1** Storage buildings or areas for cylinders should be fire resistant, well ventilated, dry and should be located away from sources of ignition or excessive heat. Cylinders should be protected from direct rays of the sun. Full and empty cylinders should be segregated.

## 7. LABELLING

**.1** The following label, in addition to, or in combination with, any label or warning required by statutes, regulations, or ordinances, is recommended for ethylene oxide containers:

**ETHYLENE OXIDE**

DANGER ! EXTREMELY FLAMMABLE, VAPOUR HARMFUL, MAY CAUSE BURNS

Keep away from heat, sparks, and open flame.

Keep container closed.

Avoid breathing vapour.

Avoid contact with skin, eyes, and clothing.

In case of contact, immediately remove all contaminated clothing including shoes, and flush skin or eyes with plenty of water for at least 15 minutes; for eyes, get medical attention. Wash clothing before re-use. Discard contaminated shoes.

## 8. PREVENTIVE MEASURES

### 8.1 Employee Education and Training

**8.1.1** Workers who handle ethylene oxide, or may be exposed to it in any form, should be instructed carefully in accepted methods of handling and be familiar with the protective equipment required for safe handling. Instruction should stress the hazard of fire or explosions, contact of the material with the skin and eyes and inhalation of the vapours.

**8.1.2** All workers should be familiar with the location of safety showers, alarm boxes, emergency ventilation system, eye-wash bottles, fire extinguishers and hose lines.

**8.1.3** Each employee should be reinstructed periodically in the hazards involved and proper emergency measures to be taken.

### 8.2 Personal Protective Equipment

**8.2.1** *Eye* ( *Protection Chemical Safety Goggles* ) — Cup-type or rubber-framed vapour proof goggles, equipped with approved impact resistant glass or plastic lenses, should be worn whenever there is danger of the material (in liquid or vapour form) coming in contact with the eyes. Goggles should be carefully fitted by adjusting the nose piece and head band to ensure maximum protection and comfort.

**8.2.2** *Respiratory Protection* — Respiratory protective equipment shall be carefully maintained, inspected, cleaned and sterilized at regular intervals, and always before use by another person. Personnel wearing such equipment shall be carefully instructed as to its operation and limitations.

**8.2.2.1** Air-supplied masks, equipped with full face pieces, shall be worn for protection under the following conditions:

a) In emergencies, when the vapour concentration is not definitely known;
b) When the harmful vapour concentration is over 2 percent by volume;
c) When the oxygen content of the air may be less than 18 percent by volume;
d) When the exposure period is to be over 30 minutes duration; and
e) In tank and equipment cleaning and repair work, when (a), (b), (c) and (d) apply. A safe entry permit from authorized gas safety inspector or safety officer shall be obtained before commening the repair work.

**8.2.3** *Head Protection* — Safety or hard hats will provide protection against accidental liquid leaks, falling tools and other objects and it is beneficial to form the habit of wearing it in all plant areas.

**8.2.4** *Foot Protection* — PVC or rubber safety shoes with built-in steel toe caps are recommended. Rubbers may be worn over leather safety shoes.

NOTE — Ethylene oxide may penetrate P V C and rubber.

**8.2.5** *Body, Skin and Hand Protection* — Suits made of a suitable protective material and properly designed should be used to provide complete body protection, when necessary.

**8.2.5.1** Aprons made of suitable protective material should be worn to protect the hands from ethylene oxide.

**8.2.5.2** Sleeves made of suitable protective material should be worn when the need for complete arm protection is indicated.

**8.2.5.3** Life harness and life line should be worn by men working in tanks or other confined spaces to facilitate rescue.

**8.2.5.4** Whenever necessary, facilities for personal cleanliness should be provided and time allowed for thorough washing before lunch and at the end of the working day.

## 9. FIRST-AID

**9.1 General** — First-aid should be started at once in cases of contact with excessive amounts of ethylene oxide. Workers presenting symptoms or signs of ethylene oxide poisoning should be removed at once from the contaminated area. A physician should be called at once, notifying him of nature of case and location of the patient.

**9.2 Inhalation** — In case breathing has stopped, effective artificial respiration should be started immediately. If oxygen inhalation apparatus is available, oxygen should be administered, but only if one familiar with the operation of such apparatus is present to administer it. A physician should be called at once. In order to prevent the development of severe lung congestion (pulmonary edema), 100 percent oxygen should be administered as soon as possible after a severe exposure. Oxygen administration is most effective if expiration is made against a positive pressure of 4 cm of water. This may be accomplished readily by use of a rubber tube connected to the outlet valve of a snugly fitting face mask and inserted to a depth of not more than 4 cm below the surface of water in a suitable container. (Special masks are obtainable with adjustable gauges which regulate the positive pressure from 1 to 4 cm). The pressure resisting exhalation should be adjusted to the patients' tolerance by varying the depth of the end of the tube below the water surface. Oxygen inhalation shall be continued as long as necessary to maintain the normal colour of the skin and mucous membranes. In cases of severe exposure, the patient should breath 100 percent oxygen under positive exhalation pressure for half-an-hour

period every hour, for at least three hours. If there are no signs of lung congestion at the end of this period, and if breathing is easy and the colour is good, oxygen inhalation may be discontinued. Throughout this time, the patient should be kept comfortably warm, but not hot.

**9.2.1** Milder exposures to ethylene oxide vapours at times produce nausea and vomiting. In cases presenting such symptoms, they should be placed in bed and given warm water in sufficient amounts to aid in washing out their stomachs. A physician should be called.

**9.3 Ingestion** — Due to the nature of ethylene oxide, it is very unlikely that any of it could be taken internally, but if a person has swallowed liquid ethylene oxide or its solution, he should be made to vomit, if conscious, by having him drink a glassful or more of lukewarm water in which a teaspoonful of salt to the glassful has been dissolved; or a similar amount of warm soapy water may be used. If necessary, the patient should be encouraged to stick his finger down his throat to induce vomiting. When possible, vomiting should be induced at least three times. Following this, a tablespoonful of Epsom salt dissolved in a glass of water should be given. A physician should be called at once.

**9.4 Contact with Skin** — All clothing contaminated with liquid ethylene oxide should be removed at once. Clothing, including shoes, should not be worn again until free from ethylene oxide. Shoes may seldom be decontaminated particularly leather shoes which should be discarded completely. All affected areas of skin should be thoroughly washed with soap and water. Never give anything orally to an unconscious person.

**9.4.1** It has been noted that if shoes, which have been soaked in ethylene oxide, are worn delayed skin burns may occur. Even weak solutions which contaminate clothing may produce the same effect particularly in such areas as the genital region. These burns form blobs or water blisters out of proportion to the amount of skin damage and are usually healed in a week or ten days if properly treated.

**9.5 Contact with Eyes** — Ethylene oxide, as liquid or vapour, is capable of producing eye damage. Should it reach the eyes, the eyes should be irrigated immediately and copiously with water for 15 minutes. The eyelids should be held apart during the irrigation to ensure contact of the water with all the tissues of the surface of the eyes and lids. Should eye irritation persist, the eyes should be irrigated for a further period of 15 minutes and a physician, preferably an eye specialist, should be called in attendance.

## 10. TANK AND EQUIPMENT CLEANING AND REPAIRS

**10.1** Cleaning or making repairs inside of equipment in which ethylene oxide is contained is particularly hazardous because of its toxicity and flammability.

**10.2** Safety respiratory apparatus, protective clothing, spark-proof tools, and explosion-proof lights should be provided for repair or cleaning crews.

**10.3** Written approval of supervisor should be procured by the repair or cleaning crews.

**10.4** The liquid ethylene oxide should be pumped out or transferred. Any pressure on the equipment should be vented to a safe area or through a scrubber. The equipment should be filled with water, drained, and thoroughly washed before it is entered for any inspection or repairs.

**10.5** All connections to vessels should be blanked off and the air in the tank tested with a combustible gas indicator or a suitable detector tube approved for ethylene oxide or by any other analytical technique. Gas tests should be repeated from time to time if continued work within the equipment is necessary. A watcher supplied with the specified safety equipment should be stationed outside the equipment entrance to keep the men inside under constant observation. Additional men should be available for rescue work.

**10.6** Special ventilation is recommended during the entire time the men are cleaning, repairing, or inspecting the equipment.

**10.7** Before the equipment is returned to ethylene oxide service, an inert gas should be used to purge out all the air. If the gas used for purging forms a flammable gas-air mixture, the equipment should be filled with water and then blown with the gas, venting to a safe location until dry. Oxygen content of the vessel shall be not greater than 0.2 percent by volume.

## 11. WASTE DISPOSAL

**11.1** Waste mixtures containing ethylene oxide should not be allowed to enter drains or sewers where there is danger of the vapours becoming ignited, All openings in sewer systems should be trapped for segregation and extinguishment.

**11.2** When it becomes necessary to dispose of ethylene oxide as such, it is preferable to do so as a vapour, venting to a safe location.

**11.3** All polymeric wastes are water soluble and, as such, present no major problem. Disposal of these materials, however, depends to a great extent upon local conditions. All regulations regarding health and pollution should be followed.

( *Continued from page* 2 )

## Panel for Drafting Safety Codes for Hazardous Chemicals, CDC 18 : 4 : 1

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